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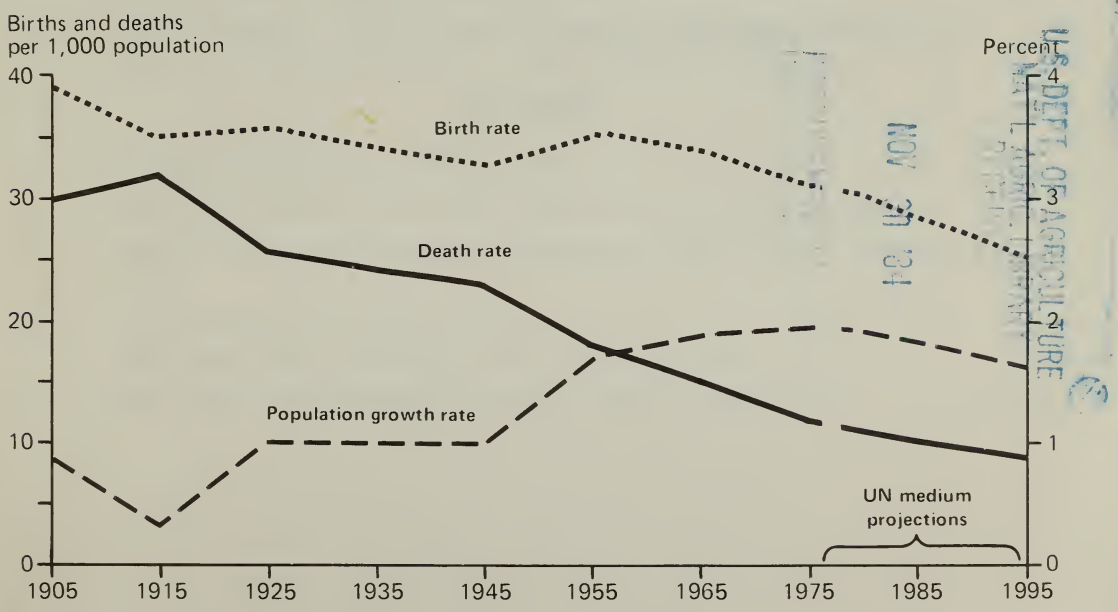
WORLD POPULATION GROWTH:

Analysis and New Projections of the United Nations

by
L. Jay Atkinson



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ABSTRACT

New projections to the year 2000 of world population growth, made by the United Nations, are discussed, and comparisons of growth in developed and developing countries, by 5-year periods, are made. Results of a regression analysis relating birth rates to death rates and income level are also presented.

KEYWORDS: Birth rates, death rates, food demand, population growth.

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SUMMARY

World population growth has accelerated during the past three centuries. In this century, population growth speeded up in the decade of the fifties, as death rates declined and birth rates increased. According to the United Nations' medium variant projection of population growth, the growth rate for the world will have reached a peak plateau over the 1960-85 period. By 5-year periods, the highest growth rate is projected at 1.95 percent per annum for 1975-80, with the growth rate declining to 1.64 percent by 1995-2000.

Most of the acceleration in population growth has been attributable to a decline in death rates, with birth rates showing only limited changes until the past decade. Growth rates have dropped below 1 percent in developed countries but have continued to expand above 2 percent in developing countries.

A cross section regression analysis of national birth rates shows that they are correlated directly with death rates and inversely with per capita income. For Asia and Africa, the principal relationship is between birth rates and death rates, whereas for Europe, birth rates are related mainly to income. For Latin America, birth rates are insignificantly related to death rates and only weakly related to income. By income levels for low-income countries, birth rates are directly related to death rates but not to income, whereas for high-income countries, birth rates are inversely related to income, and not related to death rates.

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INTRODUCTION

Some of the anxiety of a few years ago about the projection of steadily rising rates of world population growth leading to an impossible situation rather soon has diminished. Nevertheless, world population continues to grow rapidly. Over any considerable period of time, population growth is a principal component of the demand for food and farm products. When we look 25 years ahead, the uncertainty about the increase in the demand for food is as much traceable to how fast population will grow as to how much income will increase. Whereas the income elasticity of demand for food is usually estimated to range from around 0.2 percent to as high as 0.4 percent, the population-food demand elasticity remains at 1.0, since the demand for food is directly proportional to population.

Recent world population growth has been slightly below the alltime peak reached in 1960-65, when the annual growth rate was 1.93 percent. It eased to 1.87 percent in 1965-70, and then rose to 1.89 percent in 1970-75. But growth is accelerating again. For the 1975-80 period, the United Nations' medium projection is for annual growth of 1.95 percent. A slight easing of growth to 1.93 percent is projected for 1980-85, with a subsequent declining trend.

For the 25-year period 1960-85, the rate of world population growth will apparently have reached a peak plateau of a little under 2 percent per annum, with very minor variations for shorter periods. For the developed countries, however, the growth rate is declining, and it probably will have dropped to 0.83 percent for the 1980-85 period. Growth in the developing countries, on the other hand, is projected to peak in 1975-80 before beginning a slow decline, or in 1975-85 if the People's Republic of China (PRC) is excluded from the developing country group.

POPULATION GROWTH TRENDS

The trend in world population over the last 500 years has been one of accelerating growth (fig. 1 and table 1).[1] The 20th century has shown unprecedented growth, and the principal impetus has been a secular decline in death rates (fig. 2) and a slower, uneven decline in birth rates.

In the first decade of this century, the death rate was around 30 per 1,000 population, and the birth rate, about 40 per 1,000, giving a population growth rate of 1 percent annually. The population growth rate was sharply reduced in the next decade as World War I lowered birth rates and, abetted by the influenza epidemic late in the decade, increased death rates.

In the twenties, there was an increase in the birth rate and a sharp drop in the death rate. This combination pushed world population growth back up to the 1-percent level, where it remained through the thirties and the forties, as first the depression and then World War II brought declines in the birth rate that about matched the secular decline in the death rate.

Then in the fifties, birth rates rose again—nearly reaching the level of the twenties—and death rates dropped sharply. This brought the rapid rise in world population that continued during the sixties as a gradual downturn in the birth rate was more than matched by a continued drop in death rates.

[1]This section is based heavily on *World Population Growth and Response—1965-1975—a decade of global action*, Population Reference Bureau, Apr. 1976, p. 4.

Table 1--World population, 1950-2000

Population	1950	1955	1960	1965	1970	1975	1980	1985	1990	1995	2000
						Millions					
World	2,501	2,722	2,986	3,288	3,610	3,967	4,373	4,816	5,279	5,761	6,253
Developed countries	857	915	976	1,036	1,084	1,132	1,181	1,231	1,278	1,320	1,361
Developing countries	1,644	1,808	2,010	2,251	2,526	2,835	3,192	3,585	4,001	4,441	4,893
PRC	558	605	654	710	772	839	908	973	1,031	1,090	1,148
Excluding PRC	1,086	1,203	1,356	1,541	1,754	1,996	2,284	2,612	2,970	3,351	3,745

Source: U.N. medium variant projection. United Nations Working Paper No. 55, May 1975.

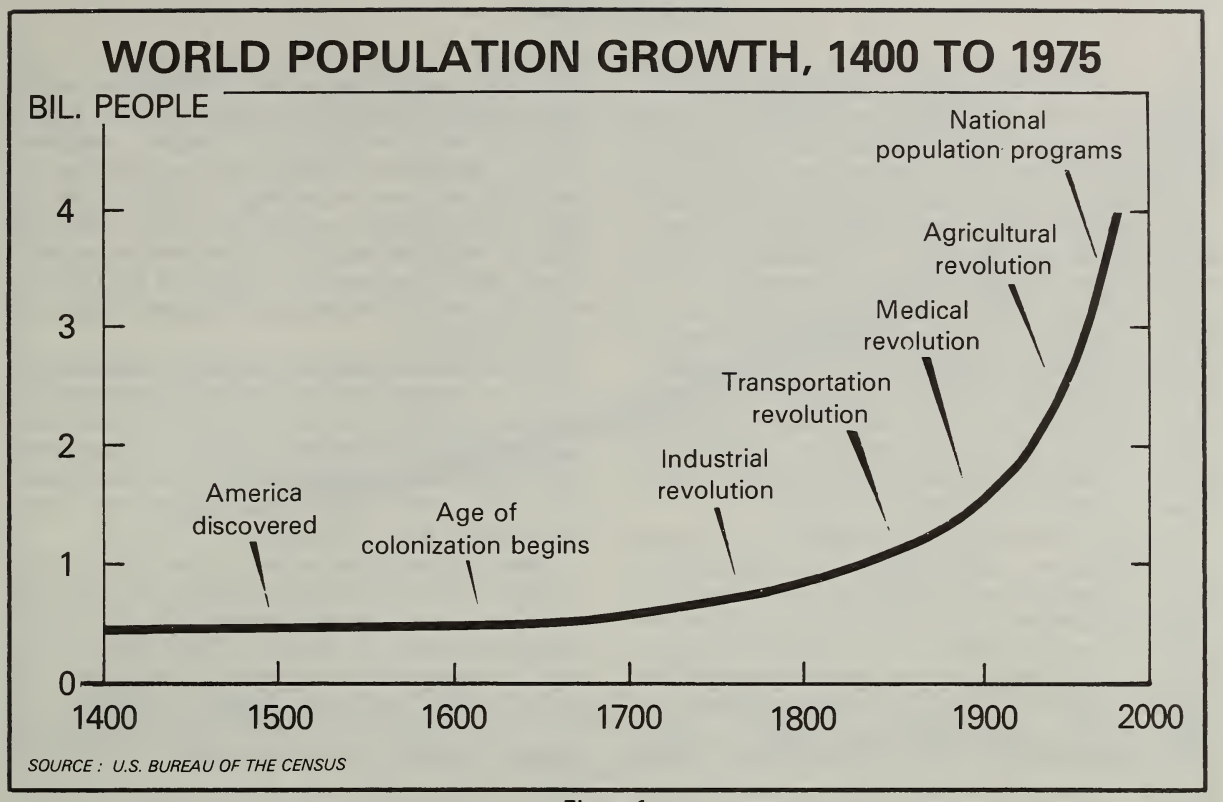


Figure 1

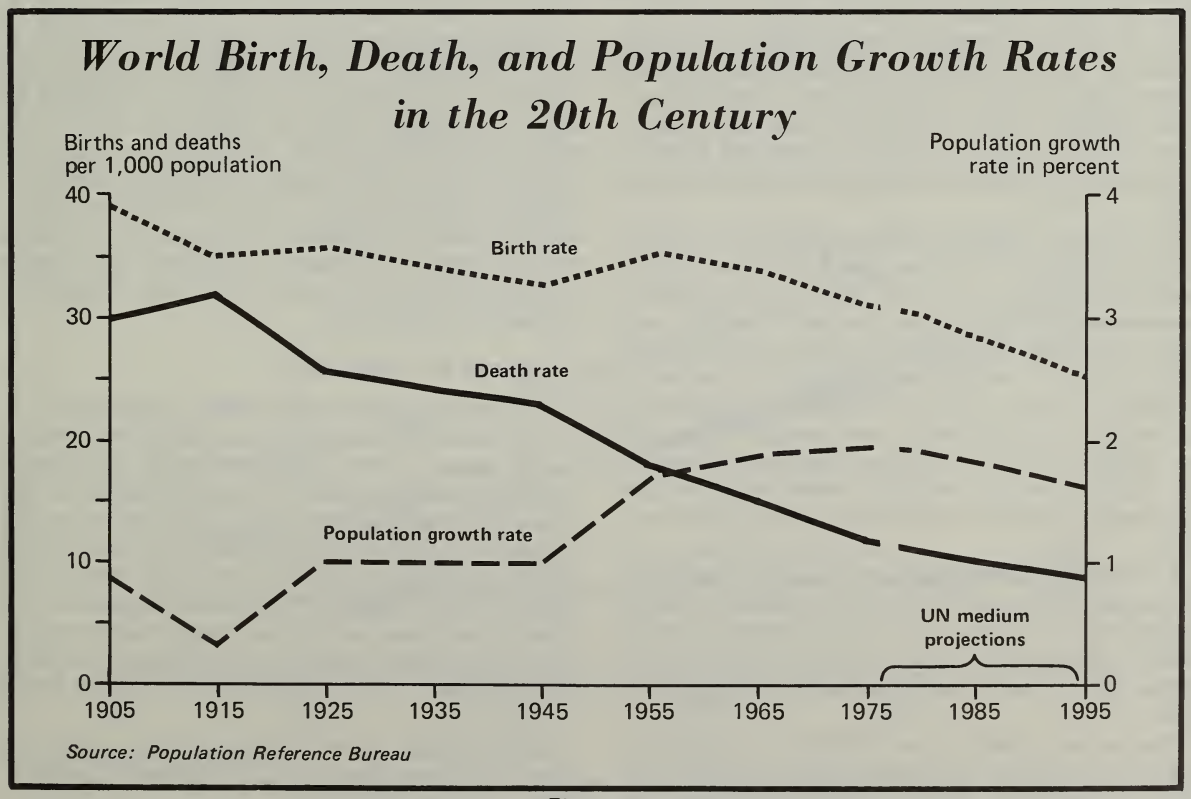


Figure 2

PROJECTIONS

Based on the U.N. medium variant of world population growth, the prospects are that the peak population growth rate attained in the sixties is leveling off, although the growth rate is expected to edge up a bit in the next 10 years before beginning a gradual decline in the 1980's. By 5-year periods, the peak growth rate of 1.95 percent annually in 1975-80 is projected to ease successively to 1.93, 1.84, 1.75, and 1.64 during the rest of this century. Each of the three variants of the United Nations' projections shows some easing in world population growth during 1960-85, but each variant also shows different periods for peak growth. The low variant puts the 5-year peak in 1960-65, the medium locates it in 1975-80, and the high, in 1980-85 with a very slow subsequent easing.

The projected easing of population growth rates is important for many reasons, of which production of adequate food supplies is a principal one. Under the medium variant projection, however, the number of people added to the world's population each year will continue to expand throughout this century, reaching nearly 100 million annually by 2000. The low variant projection shows a considerable decline in the rate of world population growth by the end of the century—from 1.93 percent in the past 5 years to 1.30 percent for 1995-2000. But the number of added people each year would be as large then as now, and the world total would be 5.8 billion, or 1.8 billion more than at present. Thus, despite prospects for a slowed population growth rate, it will be a long time before there will be a reduced need for expanded production of food, clothing, housing, and educational services.

For the year 2000, the high and low projections for the world are 5.8 billion and 6.6 billion people, respectively. For the population in developing countries—excluding the People's Republic of China—the high and low projections are 4 billion and 3.5 billion people, respectively, reflecting a somewhat larger relative difference in high and low levels. The difference between the high and low projections for the PRC and India combined is 291 million people—which is about equal to the projected population of North America in the year 2000.

A brief look at the accuracy of earlier population projections in predicting 20th century trends reminds us of the uncertainty inherent in such forecasts. Projections of 30 to 40 years ago did not foresee the strong population trend of the past 25 years.

Going back just to the 1957 U.N. projection (fig. 3), we see that the intermediate projection of world population in the year 2000 was the same as the current medium projection of 6¼ billion people. The difference between the high and low projections was much wider then—2 billion, compared with the difference of 800 million between the current high and low projections for 2000. Even the high 1957 projection was below actual growth to date. So, while the projection then was for a slower growth rate in the next two decades, it did not foresee the extent of slackening in the growth rate that is now expected.

Note on Data Quality and Another Interpretation. The data reported from all of the countries of the world are of widely varying quality. Some countries (e.g., PRC) have not taken a census in many years; others have limitations that affect an accurate count, and birth and death registrations are often unsystematic and incomplete.

Lester R. Brown has made an interpretation that is quite different from the implication in this bulletin. Using the same sources—that is the United Nations and the U.S. Bureau of the Census, "...except for those countries where more recent data are available from published studies or national surveys"[2] he finds that world population growth dropped sharply between 1970 and 1975. In that 5-year period, world population growth dropped from a 1.90-percent annual rate (1970) to a 1.64-percent annual rate (1975), according to Brown.

The latter growth rate is equal to the U.N.'s medium projected rate for 1995-2000. The annual increase in the world's population is estimated by Brown to decline from 69 million in 1970 to 64 million in 1975. This is in sharp contrast to the U.N. projections that shows a peak rate attained in 1975-80, followed by a slow decline to 1995-2000. However, the decline in the rate is so gradual that the annual increase in population gets larger during each 5-year period, reaching 98 million annually in 1995-2000.

Projections for 1950-2000

Now let us turn in more detail to the new U.N. projections by 5-year periods for 1950-2000 (table 1).

The strong growth projected for the developing countries contrasts with the slower growth for the developed countries (fig. 4). In 1975, the developing countries (including the PRC) had 71 percent of the world's population (table 2). By 2000, these same countries are projected to have 78 percent (although they may not all be categorized as developing countries by that time). Developing countries are projected to account for 90 percent of world

[3] *World Population Trends: Signs of Hope, Signs of Stress*, Worldwatch Paper No. 8, Worldwatch Institute, Wash., D.C., Oct. 1976, p. 33.

United Nations' World Population Projections in 1957 and 1975 from 1950 to 2000

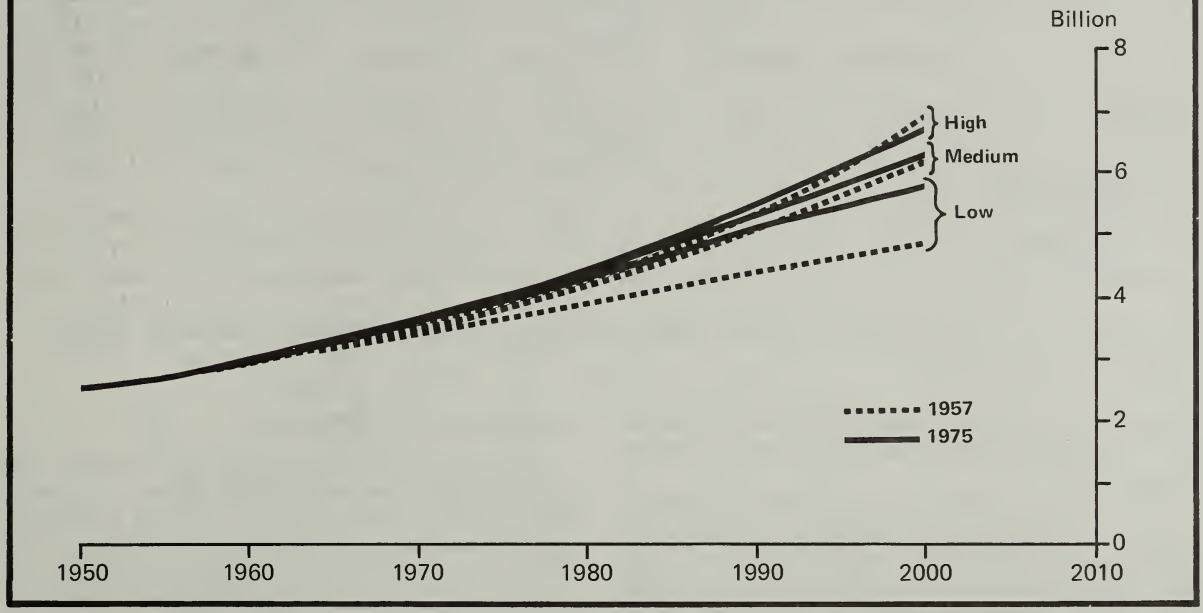
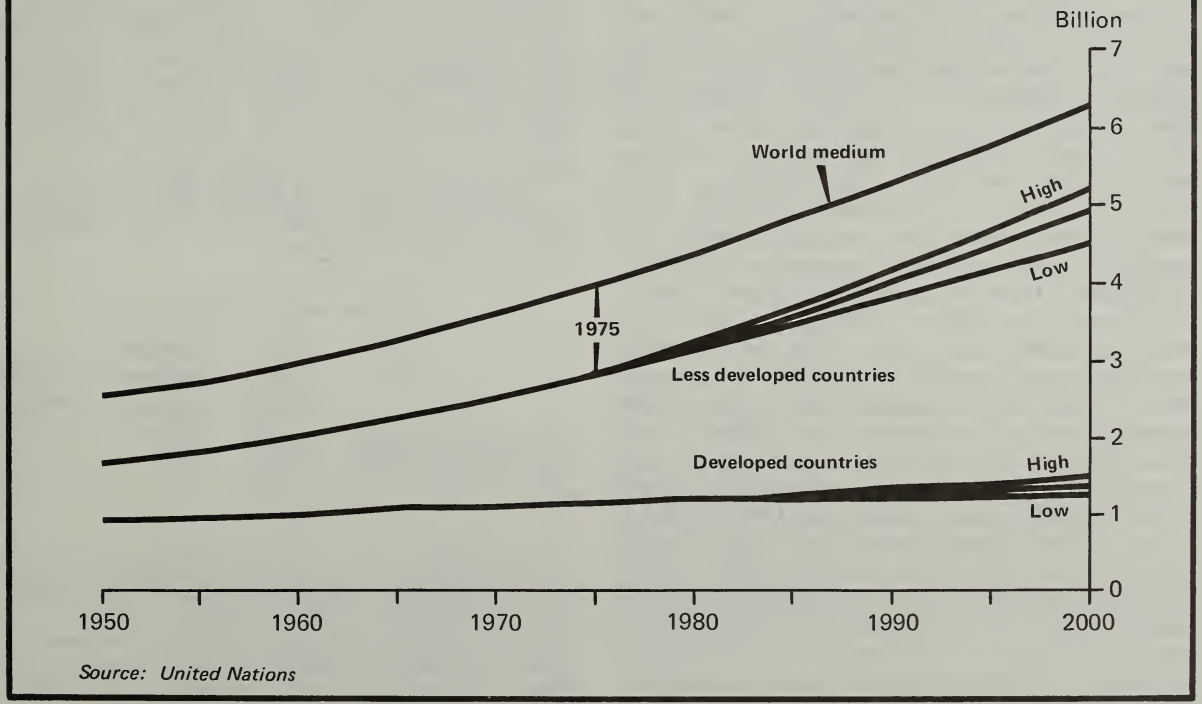


Figure 3

World Population from 1950 to 2000



Source: United Nations

Figure 4

Table 2--World population, 1975 and 2000

Item	1975		2000		Increase	
	Population	Share of total	Population	Share of total	Total	Share of total
	Millions	Percent	Millions	Percent	Millions	Percent
World	3,967	100	6,253	100	2,277	100
Developing countries	2,835	71	4,893	78	2,058	90
Developed countries	1,132	29	1,360	22	228	10

Source: U.N. medium variant projection. United Nations Working Paper No. 55, May 1975.

population growth over the 25-year period, and for over 95 percent of world population growth during the nineties.

The decline in birth rates in the developing countries has about paralleled that of the developed countries (fig. 5). The big difference is in the level. Through the fifties and into the sixties, birth rates in developing countries were still above 40 per 1,000—not far from the rates that had prevailed almost universally until about the 18th century. Death rates in the developing countries were over 20 per 1,000 in the fifties, giving a population growth rate of nearly 2 percent per annum.

From 1950 to 1975, the decline in death rates exceeded the decline in birth rates in the developing countries, so that the population growth rate increased, reaching 2.31 percent per annum in the most recent 5-year period (table 3). Projections are for the population growth rate to rise to 2.37 percent in 1975-80, and then to begin declining as the drop in the birth rate exceeds that of the death rate. Population growth in developing countries is projected to drop to below 2 percent by the end of the century. However, by that time, these countries will have nearly 5 billion people and will be adding over 90 million each year. Thus, the absolute expansion will remain large for an extended period. If the PRC is excluded from the developing country group, as is often done in food demand calculations, the first slackening in the population growth rate of the developing countries is delayed another 5 years—that is, until after 1985 (table 3).

In the developed countries, only small further declines are expected in the birth rate, but the death rate may rise a little, reflecting the aging of the population. The net result is a drifting downward in the growth rate from about 0.85 percent annually at present to 0.60 percent by the end of the century.

Implications for Food Demand

As shown in figure 5, the population growth rate in developed countries dropped below 1 percent in 1965-70 and is drifting lower, whereas the growth rate in developing countries pushed up above 2 percent in the late fifties, has continued upward, and is projected to peak out at 2.37 percent in the current period, 1975-80.

As mentioned above, 90 percent of the growth in world population in the next 25 years is projected to occur in the developing countries (table 1). The International Food Policy Research Institute reports that of the projected increase in demand for food from 1970 to 1985 in the food-deficit countries, 80 percent will come from population growth.[3] In the United States, food consumption has risen about 25 percent since 1960. While population has advanced nearly 20 percent, per capita consumption has risen only about 5 percent.

Income elasticities in developing countries are considerably higher than those of the developed countries, as indicated below:[4]

	Income elasticities for—		
	Total food calories	Calories of animal origin	Animal protein
Developed countries	.08	.24	.28
Developing countries	.22	.58	.56

[3]Meeting Food Needs in the Developing World, *Research Report* No. 1, International Food Policy Research Institute, Washington, D.C., Feb. 1976, p. 18.

[4]Council Study of Trends in World Supply & Demand of Major Agricultural Commodities (1975), Organization for Economic Cooperation and Development, Paris, Nov. 21, 1975.

Table 3--Selected world demographic indicators, 1950-2000

Item	1950-55	1955-60	1960-65	1965-70	1970-75	1975-80	1980-85	1985-90	1990-95	1995-2000
					Percent					
Average annual population growth rate:	1.69	1.85	1.93	1.87	1.89	1.95	1.93	1.84	1.75	1.64
World	1.69	1.85	1.93	1.87	1.89	1.95	1.93	1.84	1.75	1.64
Developed countries	1.30	1.29	1.21	.90	.86	.85	.83	.75	.66	.60
Developing countries	1.90	2.13	2.27	2.30	2.31	2.37	2.32	2.20	2.09	1.94
Excluding PRC	2.07	2.42	2.60	2.62	2.62	2.73	2.73	2.60	2.43	2.26
					Million					
Five-year change in population:										
World	221	264	302	322	357	406	443	463	482	492
Developed countries	58	61	60	48	48	49	50	47	42	41
Developing countries	164	202	241	275	309	357	393	416	440	452
					Number per 1,000 population					
Crude birth rates:										
World	35.6	34.6	33.7	32.1	31.5	31.1	30.1	28.4	26.8	25.1
Developed countries	22.9	21.9	20.5	18.1	17.2	17.4	17.4	16.8	16.0	15.6
Developing countries	42.1	40.9	39.9	38.4	37.5	36.4	34.6	32.3	30.2	27.8
Crude death rates:										
World	18.8	16.4	14.7	13.5	12.8	11.9	11.0	10.2	9.5	8.9
Developed countries	10.1	9.3	9.0	9.1	9.2	9.4	9.6	9.8	9.9	9.9
Developing countries	23.3	19.9	17.4	15.5	14.3	12.8	11.5	10.4	9.4	8.6

Source: U.N. medium variant projection. United Nations Working Paper No. 55, May 1975.

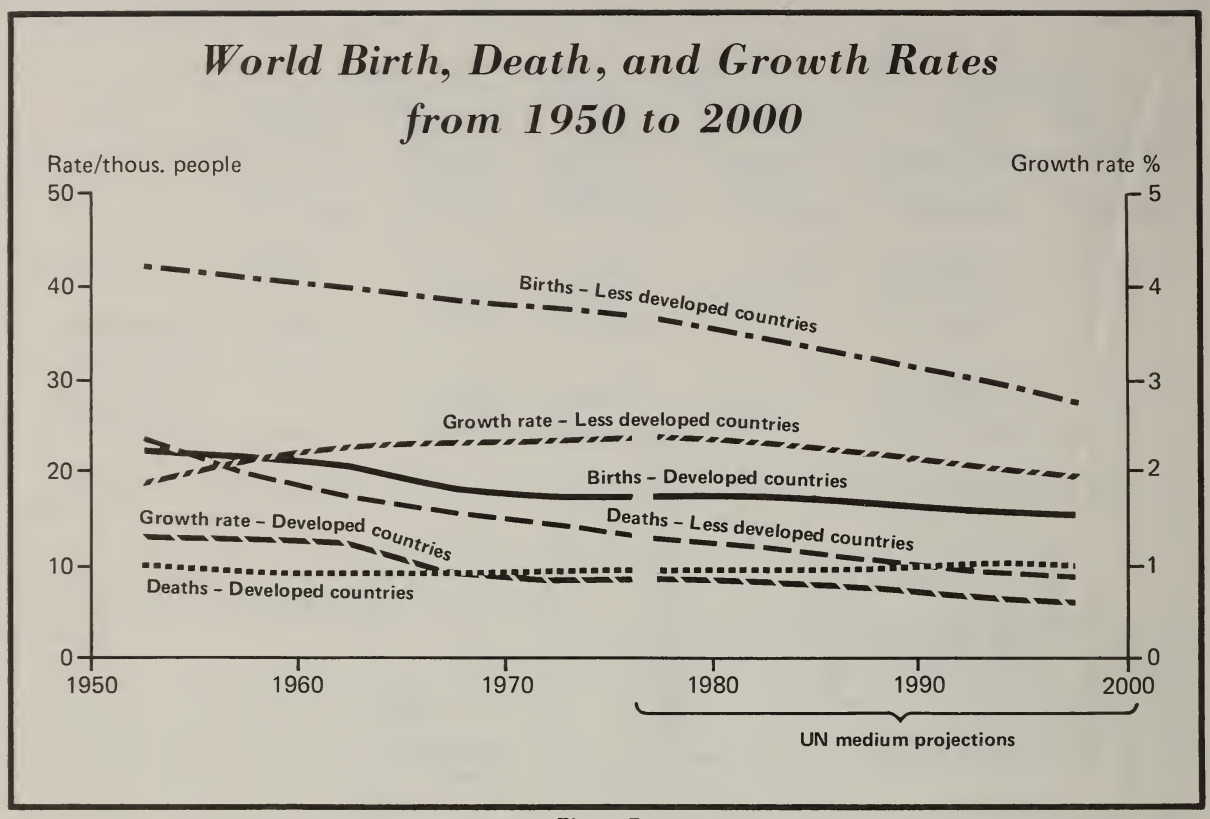


Figure 5

Coarse grains are an important part of the diet for an estimated 750 million people throughout the world. Starchy roots, bananas, and plantains are important throughout the tropics. These foods are "inferior" goods in the economic sense, in that as people's incomes rise, they consume less, not more, of them, substituting preferred foods. For the grains, the preference is very marked for food grains, chiefly rice and wheat, over the coarse grains. This is both observable by country and within countries by low income and high income groups.[5]

BIRTHS, DEATHS, AND INCOME

We now want to look at the relationship between birth rates and death rates and income level or development. These relationships are discussed over periods of time and then examined in a cross section analysis.

Historical Relationships

The general, historical pattern of population and development is that death rates fall more rapidly and earlier than do birth rates as countries begin to develop economically. Between the time that death rates have fallen and the time that birth rates make an appreciable decline, there is a transition period of rapid population growth. As countries continue to develop and incomes rise, birth rates decline faster than death rates, slowing the population growth rate.

The developed countries have largely completed this transition and now have low birth rates, low death rates, and slow population growth. The main exceptions are the relatively new, lightly populated countries, such as Australia and New Zealand, where birth and population growth rates are still relatively high.

Most of the developing countries are in the transitional growth stage and seem to be passing through it rather slowly, obtaining population growth rates which have reached unprecedented highs. Death rates have fallen rather steeply and are expected to continue declining to the end of this century (fig. 5). Birth rates have declined less

[5]Ibid., p. 41, footnote.

rapidly, although they are projected to fall as fast as death rates within the next decade or so.

Recently developed countries, such as Japan and Israel, have had sharp drops in birth rates and rapid advances in incomes. A few of the developing countries that are making rapid progress are having appreciable declines in birth rates, especially the small, heavily populated countries in the Orient—South Korea, Taiwan, and the city states of Hong Kong and Singapore. Other populous, rapidly developing countries, especially Mexico and Brazil, and to a lesser extent Thailand, still have unusually high birth rates. Since they have developed rapidly, they have low death rates and hence, accelerated population growth rates.

This relationship between births, deaths, and development or income has not yet fully materialized for the developing countries, since most have registered little decline in birth rates. In the past 25 years, the larger decline in birth rates has occurred in developed countries (fig. 5). What is empirical and can be investigated is the present situation. To what extent are present birth rates related to death rates and to per capita income or to gross domestic product?

To answer this question, we have made a cross-section analysis of birth rates as a function of death rates and of either per capita disposable income (DI) or per capita gross domestic product (GDP).

It is not postulated that the death rate and the income variables are the "cause" of variations in the birth rate. However, the influences that affect declines in death rates and advances in income appear to also affect declines in birth rates, perhaps with some lag, especially in the case of income advances. In this analysis, income is considered to be a proxy variable for economic development.

Declines in death rates may have some influence on decisions about births, and these declines are likewise a proxy for general health and sanitation improvement. In the regression analysis, death rates are not too highly correlated with disposable income (R^2 = .11) or with GDP.

It is easy to think of a list of relevant variables other than income and death rates that may affect birth rates. Of these, an educational attainment index is a possibility, and such series have been calculated from time to time. Another possibility is some index of income distribution, or even a medium instead of a mean income. If some index of birth control usage or expenditures were available, especially for developing countries, this might be helpful.

Despite these reservations, the two independent variables chosen for this analysis—death rates and either average per capita disposable income or GDP—show considerable correlation with birth rates and provide some relationships that seem appropriate.

The regressions were first tried on countries for which disposable income data were available, and then on the larger number of countries for which mean per capita GDP data were available. Since results were quite similar, only a few comparisons of the significant income and GDP equations will be discussed. The larger number of countries with data for GDP than for disposable income is especially useful for regressions for regions and income classes where the number of observations is rather small. For the world, however, the disposable income correlations (R^2 = .73) are somewhat higher than for those with GDP (R^2 = .67). Perhaps some of the countries reporting GDP but not disposable income have less accurate data.

We used the latest available U.N. demographic estimates, which are for 1970-75, and disposable income or GDP for the years calculated in the latest U.N. national income accounts volume, which is for 1974.[6] For the disposable income per capita, we tried varying time lags between income and birth rates.

Results of Regression Analysis

Results of the regression analysis with birth rates as the dependent variable and death rates and either disposable income or GDP as independent variables are reported first for all countries (world) for which data are available. Then, results by continents and by income level are discussed. The equations are shown in table 4.

Both the death rate and per capita disposable income are strongly related to births. Income is the more important in explaining variance in the birth rate; in both the linear and the natural log equations, income accounts for about twice as much variation in birth rates. The coefficient of variation (CV) (the standard deviation divided by the mean) of income is more than twice as great as the CV for either birth or death rates. The CV for the birth rate is 43 percent; for the death rate, 40 percent; and for 1970 per capita income, 94 percent.

In the linear version, each change of 1 death per 1,000 population is accompanied by a similar change of 1 birth per 1,000 population. And each change of $1,000 in per capita income or GDP is associated with a change in the birth rate of around 8 per 1,000 population for disposable income and 6 per 1,000 for GDP. The values of the coefficients in the vicinity of the means for the other disposable income equations are not very different for each of the equations tested. These

[6]United Nations *Selected World Demographic Indicators by Countries, 1950-2000*, WP-55, May 1975, and U.N. *Yearbook of National Account Statistics*, 1974 Vol. III.

Table 4--Regression results: Birth rates related to death rates and to per capita disposable income (DI 70) or gross domestic product (GDP 70)

Area or income class	No. of Obs. (N)	R^2	Form	
A. Regressions with DI 70				
1. World	65	.726	Linear	Births = 25.46 + 1.15288 Deaths - .76319 DI 70 (9.10) (6.0) (-8.9)
2. World	65	.726	Semi-L	Births = 71.657 + .79326 Deaths - 7.8185 LDI 70 (9.9) (3.8) (-8.9)
3. World	65	.715	Semi-L	Births = 4.90560 + .18756 L Deaths - .31588 DI70 (14) (2.1) (-10.3)
4. World	65	.715	Log-Log	LBirths = 2.8222 + .35260 L Deaths - .31425 DI 70 (13.5) (4.3) (-10.4)
5. Africa	12	.79	Log-Log	LBirths = 1.96906 + .56896 L Deaths + .04191 LDI 70 (5.3) (6.5) (1.1)
6. Asia	14	.75	Log-Log	LBirths = 3.03344 + .49601 L Deaths - .11759 LDI 70 (5.4) (4.3) (-1.8)
7. L.A.	14	.28	Log-Log	LBirths = 4.58825 + .07217 L Deaths - .19728 LDI 70 (4.5) (.3) (1.90)
8. Europe	19	.40	Log-Log	LBirths = 4.87377 - .41690 L Deaths - .15203 LDI 70 (8.4) (-1.8) (-2.3)
9. Europe & Oceania	23	.50	Log-Log	LBirths = 4.98590 + .02947 L Deaths - .29736 LDI 70 (9.3) (.18) (-4.9)
10. Europe, Oceania, U.S. & Can.	25	.43	Log-Log	LBirths = 4.85988 - .03188 L Deaths - .25910 LDI 70 (9.0) (-.20) (-4.5)
11. For DI 70 more than 500	33	.53	Log-Log	LBirths = 5,62236 - .1389 Deaths - .32159 LDI 70 (12.2) (-.9) (-5.0)
12. For DI 70 less than 500	29	.50	Semi-L	Births = 12.20524 + 1.00635 Deaths + 2.8901 LDI 70 (.9) (5.1) (1.33)
13. For DI 70 less than 500	28	.578	Log-Log	LBirths = 2.35596 + .37832 L Deaths + .07235 LDI 70 (6.4) (5.9) (1.4)
14. For DI 70 more than 500	33	.49	Semi-L	Births = 77.3449 + .11586 Deaths - 7.92197 LDI 70 (7.3) (.3) (-5.2)
15. For DI 70 less than 1000	39	.575	Semi-L	Births = 47.542 + 1.02736 Deaths - 3.97357 LDI 70 (3.7) (4.3) (-2.1)
16. For DI 70 less than 1000	39	.56	Log-Log	LBirths = 3.54721 + .3491 L Deaths - .141445 LDI 70 (7.2) (4.0) (-2.4)
17. For DI 70 more than 1000 (omitting Australia, N.Z. & Can.)	19	.56	Log-Log	LBirths = 5.3961 - .54555 L Deaths - .17897 LDI 70 (8.25) (-3.39) (-2.09)

Continued

Table 4--Regression results: Birth rates related to death rates and to per capita disposable income (DI 70) or gross domestic product (GDP 70)--Continued

Area or income class	No. of Obs. (N)	R^2	Form
B. Regressions with GDP 70			
18. World	132	.67	Linear Births = 29.0331 + .8331 Deaths - .005963 GDP 70 (14.1) (7.6) (-8.5)
19. World	132	.67	Semi-L LBirths = 2.98056 + .28556 L Deaths - .0002428 GDP 70 (21.0) (5.7) (-10.3)
20. World	132	.67	Semi-L Births = 66.4114 + .47834 Deaths - 6.19780 LGDP 70 (10.8) (3.4) (-8.2)
21. World	132	.65	Log-Log LBirths = 4.6761 + .11334 L Deaths - .24251 LGDP 70 (16.2) (1.8) (-9.7)
22. Africa	46	.35	Semi-L Births = 41.4350 + .58673 Deaths - 1.65864 LGDP 70 (4.8) (3.2) (-1.4)
23. Asia & Mid-East	31	.54	Semi-L Births = 22.0535 + 1.1137 Deaths + .29951 LGDP 70 (1.7) (4.1) (.2) (Simple r for Births - deaths = .73; Bir. - LGDP 70 = .52; for Deaths - LGDP 70 = .73)
24. Asia & Mid-East	31	.61	Log-Log LBirths = 2.1229 + .5094 L Deaths + .03962 LGDP 70 (4.1) (4.9) (.8)
25. Caribbean & L.A.	26	.38	Log-Log LBirths = 4.48739 + .12794 L Deaths - .19710 LGDP 70 (5.0) (.7) (-2.2) (Income - Deaths r (-.70) greater than Income Births r = (-.60)
26. Europe	45	.74	Log-Log LBirths = 6.6489 - .23999 L Deaths - .424901 LGDP 70 (15.4) (-1.8) (-11.0)
27. For GDP 70 less than 500	82	.44	Semi-L Births = 23.6948 + .7461 Deaths + 1.3403 LGDP 70 (3.7) (7.0) (1.4) LGDP has wrong sign, but is insignificant; R higher (-.62) with Deaths than Births (-.31)
28. For GDP 70 more than 500	48	.30	Semi-L Births = 79.723 + .2241 Deaths - 7.9653 LGDP 70 (3.8) (.6) (-4.4)
29. For GDP 70 more than 500	48	.37	Log-Log LBirths = 5.8015 - .10995 L Deaths - .33857 LGDP 70 (10.3) (-.74) (-5.06) R for LB and LDea is low (-.12) but LB and LGDP have high correlation (R = .60)
30. For GDP 70 less than 1000	104	.55	Semi-L Births = 41.0438 + .7709 Deaths - 2.2930 LGDP 70 (5.4) (5.8) (-2.1)
31. For GDP 70 less than 1000	104	.56	Log-Log LBirths = 3.1036 + .3332 L Deaths - .0575 LGDP 70 (10.8) (6.37) (-1.86) Both these LGD have higher R^2 with Deaths than with Births
32. For GDP 70 more than 1000	26	.66	Log-Log LBirths = 6.4384 - 1.1539 L Deaths - .1260 LGDP 70 (8.2) (-6.6) (-1.4)

Note: Numbers in parenthesis below the coefficients are the t-values for standard error. The t-values of 2 or more are highly significant.

included log equations and semi-log equations with logs for births and deaths in the one case and for income in the other. All four of the variants explained around 70 percent of the variation in birth rates or a little more (R^2 ranged from .70 to .73). The variation in birth rates explained by the GDP equation was somewhat less (R^2 = .67), but with the larger number of observations, the error terms for each of the variables was just as satisfactory (t = 8 or 9).

Another question investigated was the appropriate lag between income and its effects on birth rates. We tried a lag of about a year, of over 2 years, and of about 10 years. The lag of a year was too short a time, and there was little difference between the 2-year and the 10-year lags in the correlation with births. The inverse relationship between births and incomes was highly significant and accounted for over half the variation in birth rates between countries.

Our sample consisted of 65 countries for the disposable income equations and 133 for the GDP equations. We chose all the countries for which births rates, death rates, and disposable income per capita for 1963, 1970, and 1972 were available for the disposable income regressions and those for which GDP for 1970 was available for that set. Each of the samples included most of the populous countries. There were enough countries to run separate regressions for the principal developing continents, and one for the developed countries and also for low-income and high-income countries. Since there was little difference between the linear and the log equations, and the latter were sometimes more appropriate, the log form is usually discussed.

In both Asia and Africa, a higher proportion of the variance in birth rates was explained by the regression (R^2 = .75 for Asia and .79 for Africa). And in each case, the principal variable was the death rate. In each continent, 14 countries were in the sample, with variations of 10 percent in death rates associated with around 5-percent variations in the same direction in birth rates. The coefficients were similar for the GDP equations, but the correlations were somewhat lower (R^2 = .55 to .60).

Income differences between countries were not significantly associated with differences in birth rates in either Asia or Africa, by any standard. In Africa, the very small coefficient had the wrong sign—that is, it was positive—but it was not statistically significant (t = 1.1). In Asia the coefficient had the right sign, but was small and not significant. We report these relationships without being sure why variations in deaths between countries in Asia and Africa are so closely related to birth rates or why variations in income between countries appear to have so little relation to variations in birth rates.

In Latin America, the relationship between birth rates and death rates was insignificant. Birth rates were rather weakly but significantly correlated with disposable income or GDP, in the expected inverse relationship, with changes of 10 percent in income associated with changes in the other direction of 2 percent in the birth rate (t = -2.2). However, income or GDP was more closely correlated with death rates (R^2 = .50) than with birth rates (R^2 = .36). All in all, the equation explained less of the variation in births rates (R^2 = .38) than it did for the other continents.

For Europe, there was a strong inverse correlation (t = -11) between birth rates and income and a weak and illogical one between birth rates and death rates that is not significant (t = -1.8). The correlation is good (R^2 = .74). Each 10-percent change in disposable income was associated with a 4-percent inverse change in birth rates.

As a partial check, we computed separate regressions for countries with per capita incomes of less than $500 in 1970 and for those with incomes of over $500, and repeated the process substituting $1,000 for the separate regression breaks.

For countries with disposable income per capita of not more than $500 in 1970, income variation between countries was not significantly related with variations in birth rates. However, death rates were correlated (R^2 = .55) with birth rates. On a linear basis, each change of 1 per 1,000 in death rates was associated with an average change in birth rates of the same size in the same direction. Birth rates were more than 3 times death rates; on a log or relative basis, each change of 10-percent in death rates was associated with a 3-percent change in birth rates. The GDP equations were consistent.

For countries with per capita incomes above $500 in 1970, death rates were insignificant in explaining birth rates, and changes in incomes were inversely associated with changes in birth rates. The principal deviations were South Africa, Libya, Kuwait, and Venezuela, where the birth rate has remained very high despite higher average incomes (fig. 6). For South Africa, the birth rate is little affected, perhaps because of a skewed income distribution, with whites having larger incomes among a predominatly black population. Kuwait, Venezuela, and Libya were not included in some of the correlations because they were so unusual that the high income had been little reflected in a declining birth rate. Perhaps the skewed distribution was important in these countries, too.

For the regressions based on disposable income or GDP of less than or more than $1,000 countries with less than $1,000 had similar positive birth-death correlations similar to those in countries under the $500 break, but for countries with an income break under $1,000, income and birth rates are just significantly inversely related. For incomes

Birth Rates by Gross Domestic Product Per Capita in Dollars, 1970

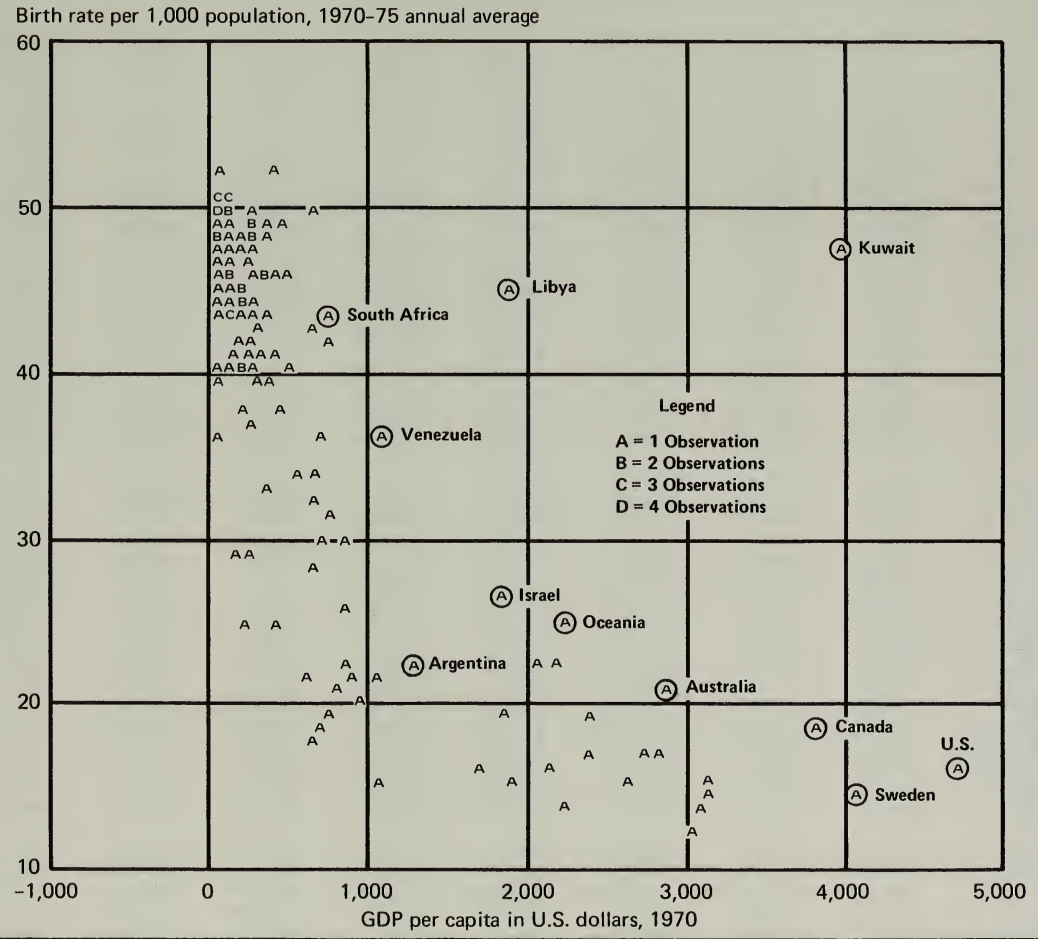


Figure 6

over $1,000, the size of the sample drops, and the results are inconclusive, with some inverse correlation between births and deaths that is unexpected and appears to be due to bad data.

Inspection of the data for countries with GDP of more than $1,000 shows that the unexpected relationships between birth rates and the two variables death rates and DI occur primarily in a group of non-European countries. This heterogeneous group with high incomes includes OPEC countries and the sparsely populated, late-developing countries such as Australia and New Zealand, as well as a few densely populated ones. In general, this group reports high income and relatively high birth rates and low death rates—sometimes incredibly low death rates. For such a heterogeneous group, more complex relationships are required to relate to variations in births.

Table 5--World population, 1950-75, and U.N. medium projections, 1980-2000, by regions, and by countries with 10 million or more in 1975

Country	1950	1955	1960	1965	1970	1975	1980	1985	1990	1995	2000
						(in 1,000)					
Africa	218,833	243,316	272,753	308,701	351,594	401,138	460,686	531,407	613,714	707,994	813,119
Eastern Africa	61,878	68,807	77,193	87,727	99,818	114,498	131,992	152,868	177,581	206,659	239,861
Ethiopia	16,675	18,202	20,024	22,231	24,855	27,975	31,522	35,739	40,708	46,673	53,665
Kenya	6,018	7,001	8,115	9,527	11,247	13,251	15,688	18,605	22,102	26,263	31,020
Uganda	5,969	6,687	7,551	8,578	9,806	11,353	13,222	15,423	17,996	20,932	24,160
Middle Africa	26,258	28,758	31,775	35,766	40,446	45,310	51,201	58,356	66,735	76,485	87,732
Zaire	13,055	14,468	16,151	18,651	21,638	24,485	27,952	32,139	37,061	42,809	49,450
Northern Africa	51,806	58,051	65,732	74,268	85,627	98,185	113,055	130,334	149,748	170,525	191,824
Algeria	8,753	9,715	10,800	11,923	14,330	16,792	19,828	23,501	27,741	32,226	36,663
Egypt	20,461	22,990	25,929	29,389	33,329	37,543	42,144	47,191	52,640	58,438	64,588
Morocco	8,953	10,132	11,640	13,139	15,126	17,504	20,384	23,788	27,633	31,752	35,904
Sudan	9,067	10,210	11,770	13,540	15,695	18,268	21,420	25,147	29,425	34,123	38,977
Southern Africa	14,354	16,123	18,164	20,779	24,202	27,678	31,950	36,848	42,321	48,591	55,669
South Africa	12,458	14,065	15,925	18,337	21,500	24,663	28,533	32,955	37,881	43,539	49,951
Western Africa	64,538	71,578	79,889	90,160	101,501	115,469	132,488	153,000	177,329	205,734	238,034
Nigeria	34,331	38,241	42,947	48,676	55,073	62,925	72,596	84,400	98,497	115,258	134,924
Latin America	163,925	187,627	215,577	247,324	283,020	324,092	371,631	425,635	485,585	550,603	619,929
Caribbean	16,725	18,314	20,226	22,489	24,616	27,116	30,016	33,272	36,847	40,662	44,504
Middle America	35,835	41,538	48,689	57,202	67,003	78,652	92,631	109,180	128,160	149,315	172,670
Mexico	26,606	30,949	36,369	42,859	50,313	59,204	69,965	82,803	97,585	114,055	132,244
Temperate South America	25,437	28,065	30,821	33,493	36,073	38,747	41,564	44,407	47,152	49,719	52,078
Argentina	17,150	18,928	20,611	22,179	23,748	25,384	27,064	28,678	30,189	31,584	32,861
Chile	6,091	6,743	7,585	8,510	9,369	10,253	11,235	12,303	13,379	14,405	15,355
Tropical South America	85,928	99,709	115,841	134,139	155,328	179,578	207,421	238,774	273,426	310,907	350,676
Brazil	52,901	61,864	71,539	82,541	95,204	109,730	126,389	145,082	165,757	188,273	212,507
Colombia	11,689	13,593	15,905	18,691	22,075	25,890	30,215	35,050	40,324	45,874	51,464
Peru	7,915	8,775	9,993	11,440	13,248	15,326	17,711	20,424	23,478	26,871	30,561
Venezuela	5,145	6,073	7,635	9,105	10,559	12,213	14,134	16,326	18,706	21,143	23,552
Northern America	166,073	181,741	198,662	214,040	226,389	236,841	248,833	262,344	275,136	286,163	296,199
Canada	13,737	15,736	17,909	19,644	21,406	22,801	24,576	26,511	28,357	30,000	31,613
United States	152,271	165,932	180,671	194,303	204,879	213,925	224,133	235,701	246,639	256,015	264,430
East Asia	674,821	728,914	787,980	854,003	926,221	1,005,665	1,087,008	1,164,108	1,232,719	1,301,064	1,369,069
China	558,190	605,081	654,488	710,324	771,840	838,803	907,609	973,155	1,031,142	1,089,572	1,147,987
Japan	83,625	89,815	94,096	98,881	104,331	111,120	117,546	122,445	126,213	129,567	132,929
Other East Asia	33,005	34,018	39,396	44,799	50,050	55,742	61,853	68,508	75,363	81,925	88,153
Korea	30,096	30,524	35,221	39,814	44,613	49,800	55,370	61,439	67,707	73,726	79,456
Korea, Dem. People's Republic of	9,740	9,100	10,526	12,100	13,892	15,852	17,926	20,179	22,581	25,022	27,457
Korea, Rep. of	20,356	21,424	24,695	27,714	30,721	33,949	37,444	41,260	45,126	48,704	51,998
South Asia	692,916	762,815	855,711	970,157	1,101,199	1,249,793	1,426,843	1,624,722	1,836,258	2,053,610	2,267,266
Eastern South Asia	173,228	191,741	216,986	247,747	282,969	323,836	370,855	423,221	478,712	535,640	591,622
Burma	18,380	20,166	22,254	24,754	27,748	31,240	35,195	39,687	44,573	49,701	54,902
Indonesia	75,449	82,791	92,701	105,070	119,467	136,044	154,869	175,471	196,576	217,623	237,507
Malaysia	6,187	6,934	7,908	9,080	10,466	12,093	13,998	16,076	18,260	20,239	22,054
Philippines	20,988	23,913	27,561	32,030	37,604	44,437	52,203	60,842	70,119	79,876	89,707
Thailand	20,010	22,762	26,392	30,641	35,745	42,093	49,473	57,784	66,752	76,135	85,618
Vietnam	24,600	26,495	30,200	34,835	39,106	43,451	48,634	54,612	61,302	68,491	75,802

Continued

Table 5--World population, 1950-75, and U.N. medium projections, 1980-2000, by regions, and by countries with 10 million or more in 1975--Continued

Country	1950	1955	1960	1965	1970	1975	1980	1985	1990	1995	2000
						(in 1,000)					
Vietnam Dem.	12,973	14,080	16,100	18,711	21,154	23,798	26,901	30,455	34,431	38,729	43,141
Vietnam, Rep. of	11,627	12,415	14,100	16,124	17,952	19,653	21,733	24,157	26,871	29,762	32,661
Middle South Asia	475,345	520,353	580,563	655,811	741,710	837,799	953,997	1,083,462	1,221,669	1,362,961	1,501,213
Afghanistan	11,660	12,552	13,736	15,097	16,978	19,280	22,038	25,207	28,739	32,598	36,654
Bangladesh	41,037	45,607	51,446	58,795	67,692	73,746	84,803	98,003	112,694	128,298	144,347
India	352,664	384,235	427,802	482,365	543,132	613,217	694,309	782,890	876,051	969,748	1,059,429
Iran	16,913	19,020	21,554	24,662	28,359	32,923	38,492	44,904	51,897	59,221	66,593
Nepal	8,000	8,590	9,180	10,100	11,232	12,572	14,231	16,186	18,348	20,771	23,196
Pakistan	36,450	40,609	45,851	52,415	60,449	70,560	82,952	97,354	113,239	129,877	146,924
Sri Lanka	7,678	8,723	9,889	11,164	12,514	13,986	15,465	16,922	18,530	20,002	21,339
Western South Asia	44,343	50,721	58,161	66,599	76,520	88,158	101,992	118,039	135,877	155,009	174,432
Iraq	5,180	5,940	6,847	7,976	9,356	11,067	13,145	15,578	18,277	21,242	24,445
Turkey	20,809	23,859	27,509	31,151	35,232	39,882	45,363	51,692	58,656	65,843	72,588
Europe	391,968	407,616	425,154	444,990	459,085	473,128	486,611	500,090	513,779	526,994	539,812
Eastern Europe	88,500	92,967	96,709	100,055	102,942	106,297	109,717	112,889	115,780	118,645	121,749
Czechoslovakia	12,389	13,093	13,654	14,159	14,339	14,757	15,189	15,579	15,941	16,329	16,807
German, Dem. Rep.	18,387	17,944	17,240	17,019	17,058	17,193	17,358	17,553	17,761	17,977	18,233
Hungary	9,338	9,825	9,984	10,153	10,338	10,534	10,721	10,841	10,907	10,972	11,069
Poland	24,824	27,281	29,561	31,496	32,473	33,841	35,316	36,685	37,824	38,822	39,846
Romania	16,311	17,325	18,403	19,027	20,244	21,178	22,057	22,908	23,793	24,755	25,758
Northern Europe	72,477	73,832	75,834	78,566	80,309	81,975	83,740	85,501	87,424	89,355	91,320
United Kingdom	50,616	51,199	52,559	54,520	55,480	56,427	57,519	58,667	59,993	61,363	62,794
Southern Europe	108,552	113,120	118,098	123,357	127,696	132,354	137,106	141,875	146,669	151,293	155,685
Italy	46,769	48,200	50,223	51,944	53,565	55,023	56,319	57,508	58,677	59,801	60,876
Spain	27,868	29,056	30,303	31,913	33,779	35,433	37,209	39,080	41,041	43,008	44,924
Yugoslavia	16,346	17,519	18,402	19,434	20,371	21,322	22,299	23,236	24,107	24,908	25,653
Western Europe	122,439	127,697	134,513	143,012	148,137	152,503	156,049	159,825	163,906	167,702	171,058
France	41,736	43,428	45,684	48,758	50,670	52,913	55,103	57,052	58,816	60,508	62,131
German, Fed. Rep. of	49,989	52,382	55,433	59,012	60,700	61,682	62,023	62,858	64,188	65,370	66,242
Netherlands	10,114	10,751	11,480	12,292	13,032	13,599	14,107	14,614	15,116	15,588	16,010
Oceania	12,632	14,139	15,771	17,507	19,323	21,308	23,482	25,777	28,109	30,431	32,715
Australia and New Zeland	10,127	11,376	12,687	14,015	15,371	16,840	18,403	19,997	21,549	23,038	24,512
Australia	8,219	9,240	10,315	11,387	12,552	13,809	15,140	16,490	17,796	19,034	20,245
U.S.S.R.	180,075	196,159	214,329	230,936	242,768	255,038	268,115	281,540	293,742	304,607	315,027
World Total	2,501,243	2,722,326	2,985,937	3,287,657	3,609,600	3,967,005	4,373,210	4,815,621	5,279,041	5,761,465	6,253,135
More developed region	857,305	914,772	975,748	1,036,355	1,084,018	1,131,715	1,181,072	1,230,823	1,227,570	1,320,089	1,360,557
Less developed region	1,643,938	1,807,554	2,010,189	2,251,302	2,525,582	2,835,290	3,192,138	3,584,798	4,001,471	4,441,376	4,892,579

Source: United Nations, Selected World Demographic Indicators, by countries 1950-2000, W.P. 55, 28 May 1975.

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